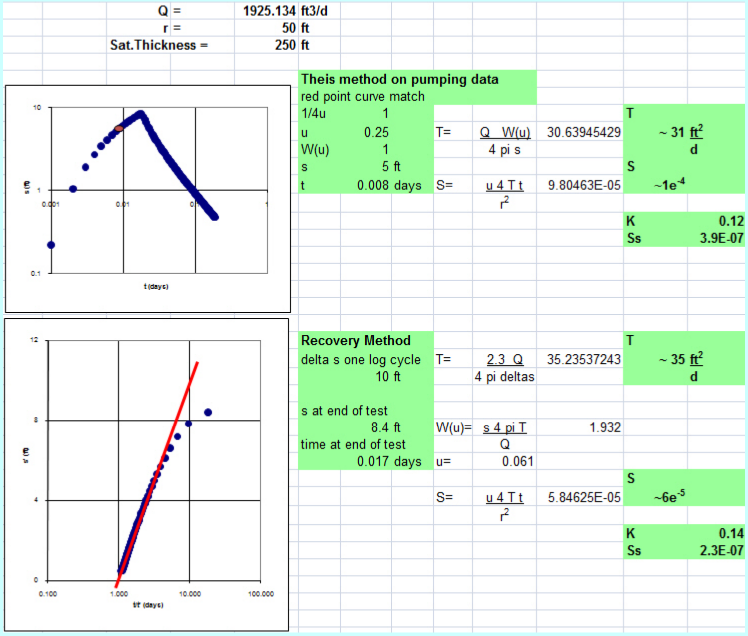
RECOVERY ANALYSIS



Q = 1925.134 ft3/d
r = 50 ft
Sat.Thickness = 250 ft

Theis method on pumping data
red point curve match

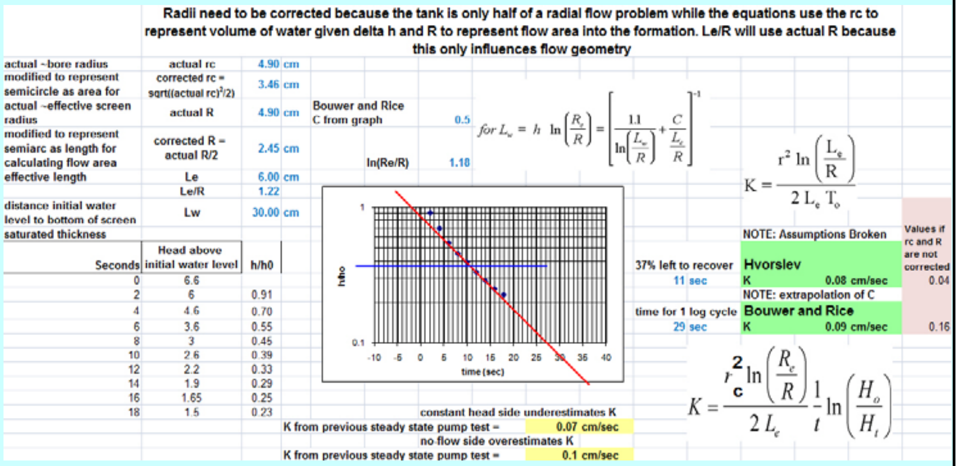
1/4u	1				**T**	
u	0.25	T=	$\frac{Q\ W(u)}{4\ pi\ s}$	30.63945429	**~ 31 $\frac{ft^2}{d}$**	
W(u)	1					
s	5 ft				**S**	
t	0.008 days	S=	$\frac{u\ 4\ T\ t}{r^2}$	9.80463E-05	**~1e^{-4}**	
					K	**0.12**
					Ss	**3.9E-07**

Recovery Method

delta s one log cycle		T=	$\frac{2.3\ Q}{4\ pi\ deltas}$	35.23537243	**T**	
	10 ft				**~ 35 $\frac{ft^2}{d}$**	
s at end of test						
	8.4 ft	W(u)=	$\frac{s\ 4\ pi\ T}{Q}$	1.932		
time at end of test						
	0.017 days	u=	0.061			
					S	
		S=	$\frac{u\ 4\ T\ t}{r^2}$	5.84625E-05	**~6e^{-5}**	
					K	**0.14**
					Ss	**2.3E-07**

Time since slug sec	**h above initial water level cm**
	6.6
2	**6**
4	**4.6**
6	**3.6**
8	**3**
10	**2.6**
12	**2.2**
14	**1.9**
16	**1.65**
18	**1.5**

Bore radius = 4.9cm
Screen Length = 6cm
Saturated thickness = 30cm



Radii need to be corrected because the tank is only half of a radial flow problem while the equations use the rc to represent volume of water given delta h and R to represent flow area into the formation. Le/R will use actual R because this only influences flow geometry

actual ~bore radius	actual rc	4.90	cm
modified to represent semicircle as area for	corrected rc = sqrt((actual rc)^2/2)	3.46	cm
actual ~effective screen radius	actual R	4.90	cm
modified to represent semiarc as length for calculating flow area	corrected R = actual R/2	2.45	cm
effective length	Le	6.00	cm
	Le/R	1.22	
distance initial water level to bottom of screen	Lw	30.00	cm
saturated thickness			

Bouwer and Rice C from graph 0.5

ln(Re/R) 1.18

$$\text{for } L_w = h \quad \ln\left(\frac{R_e}{R}\right) = \left[\frac{1.1}{\ln\left(\frac{L_w}{R}\right)} + \frac{C}{\frac{L_e}{R}}\right]^{-1}$$

Seconds	Head above initial water level	h/h0
0	6.6	
2	6	0.91
4	4.6	0.70
6	3.6	0.55
8	3	0.45
10	2.6	0.39
12	2.2	0.33
14	1.9	0.29
16	1.65	0.25
18	1.5	0.23

$$K = \frac{r^2 \ln\left(\frac{L_e}{R}\right)}{2\,L_e\,T_o}$$

NOTE: Assumptions Broken

		Values if rc and R are not corrected
37% left to recover 11 sec	**Hvorslev** K 0.08 cm/sec	0.04
	NOTE: extrapolation of C	
time for 1 log cycle 29 sec	**Bouwer and Rice** K 0.09 cm/sec	0.16

$$K = \frac{r_c^2 \ln\left(\frac{R_e}{R}\right)}{2\,L_e}\,\frac{1}{t}\ln\left(\frac{H_o}{H_t}\right)$$

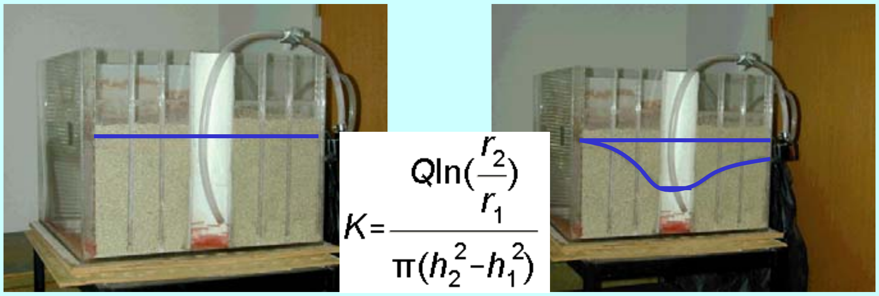
constant head side underestimates K

K from previous steady state pump test = 0.07 cm/sec

no flow side overestimates K

K from previous steady state pump test = 0.1 cm/sec

Left side: (r,h) (5,avoid using pumping well) (12.5, 21.5) (19.5,22) (27,25.5)
Right side:(r,h) (5,avoid using pumping well) (13, 18.5) (19.5,22) (27,25.5)
Q = 1015 ml / 18 sec



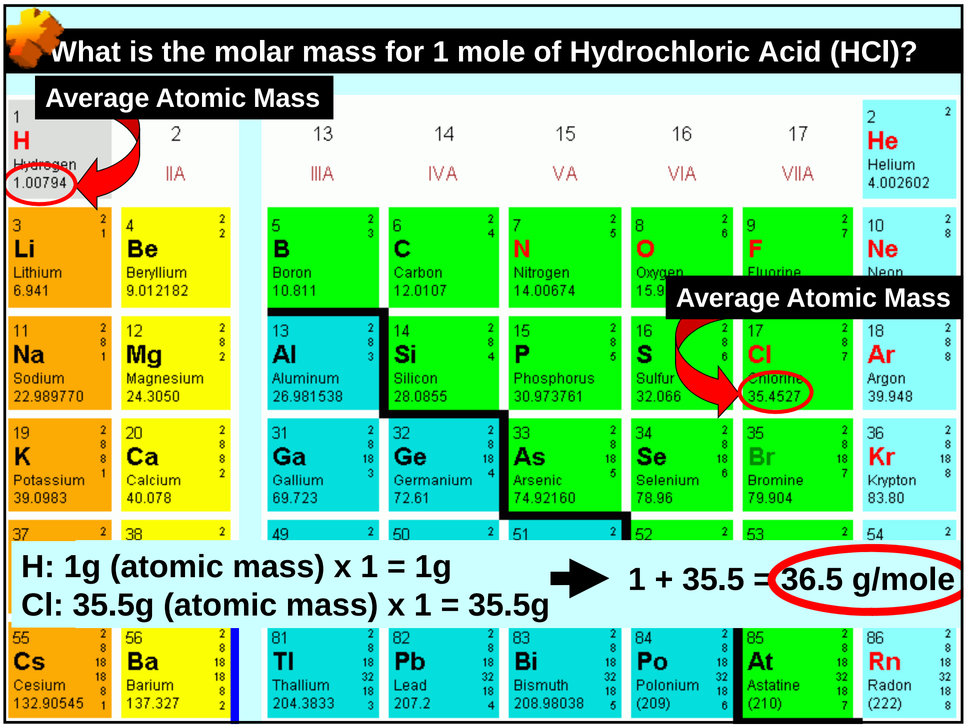
$$K = \frac{Q\ln\left(\frac{r_2}{r_1}\right)}{\pi\left(h_2^2 - h_1^2\right)}$$

$$\text{Kleft} = \frac{\frac{1015\text{cm}^3}{18\text{sec}} \ln\left(\frac{27}{12.5}\right)}{3.14((25.5\text{cm})^2-(21.5\text{cm})^2)}$$

K = 0.07 cm / sec

$$\text{Kright} = \frac{\frac{1015\text{cm}^3}{18\text{sec}} \ln\left(\frac{20.5}{13}\right)}{3.14((20.5\text{cm})^2-(18.5\text{cm})^2)}$$

K = 0.1 cm / sec



What is the molar mass for 1 mole of Hydrochloric Acid (HCl)?

Average Atomic Mass

Average Atomic Mass

H: 1g (atomic mass) x 1 = 1g
Cl: 35.5g (atomic mass) x 1 = 35.5g

1 + 35.5 = 36.5 g/mole

Suppose you are given a concentrated solution of HCl labeled as 37.0% HCl, with a solution density of 1.19 g/mL
What is the Molarity of HCl?

(1) Begin with the assumption of 100 g of solution

$$\frac{37\text{g of solutes}}{100\text{g of solution (37g of solutes} + 63\text{ g of solvent)}}$$

(2) To find molarity, we need to determine the moles of HCl (solute)

$$\text{moles (mol)} = \frac{\text{mass (g)}}{\text{molar mass}\left(\frac{\text{g}}{\text{mol}}\right)} = \frac{37\text{g}}{36.5\left(\frac{\text{g}}{\text{mol}}\right)} = 1.01\text{ mol}$$

(3) Convert the known mass of solution, 100 g solution, to liters of solution, using the density of the solution:

$$\frac{100\text{ g}}{1.19\left(\frac{\text{g}}{\text{mL}}\right)}\frac{1\text{L}}{1000\text{ mL}} = 0.084\text{ L solution}$$

(4) Calculate the molarity (M)

$$\frac{1.01\text{ mol HCl}}{0.084\text{ L solution}} = 12.0\frac{\text{mol}}{\text{L}}$$

UNITS OF EXPRESSION

Equivalents and Normality (N) - units : equivalents/liter

Equivalents (eq) are similar to moles, but take into account the valence of an ion (i.e. # of reactive units)

0.002 mol L^{-1} of Ca^{2+} = 0.004 eq L^{-1} Ca^{2+}
0.001 mol L^{-1} of Na^{+} = 0.001 eq L^{-1} Na^{+}
0.003 mol L^{-1} Al^{3+} = 0.009 eq L^{-1} Al^{3+}

Normality (*N*) is another name for eq L^{-1}

Alkalinity and Hardness are important parameters that are expressed as eq L^{-1} or meq L^{-1} (more on these later)

Say a laboratory reports the concentration of Ca^{2+} in a water sample as 92 mg/L. What is the normality of Ca^{2+} ?

Valence (charge)

$$\frac{\text{Equivalent}}{\text{Liter}} = \text{Conc}(\frac{\text{mg}}{\text{L}}) \frac{1\,\text{mole}}{\text{atomic or molecular wt.}} \left| \frac{\#\text{ of equivalents}}{\text{mole}} \right|$$

$$92\,\frac{\text{mg}}{\text{L}}\,\frac{1\text{mole}}{40.08\text{g}}\,\frac{1\text{g}}{1000\text{mg}}\,\frac{2\text{equiv}}{\text{mole}} = 4.6\times10^{-3}\,\frac{\text{equiv}}{\text{L}} = 4.6\,\frac{\text{milliequiv}}{\text{L}}$$

Given the following ground water analysis:

Constituents	Conc.(ppm)
Na^{+}	145
Ca^{2+}	134
Mg^{2+}	44
HCO_3^{-}	412
SO_4^{2-}	429
Cl^{-}	34
TDS	1049.9
pH	5.5

Calculate the $[H^+]$ and $[OH^-]$ of the sample

Since pH is the negative logarithm of [H+]
the value of [H+] is $10^{-5.5}$
$[H+][OH-] = 10^{-14}$
$[OH-] = 10^{-14} / [H+] = 10^{-14} / 10^{-5.5} = 10^{-8.5}$